

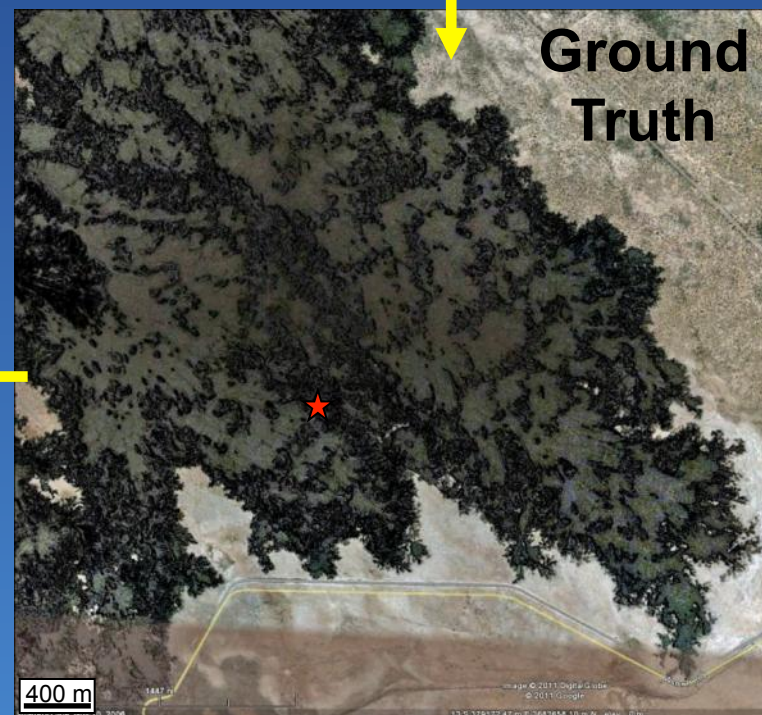
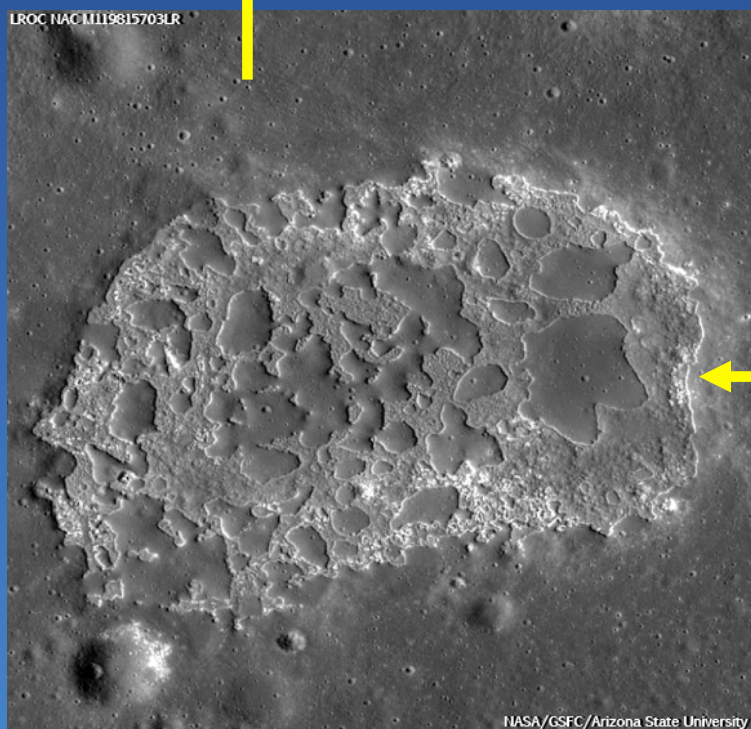
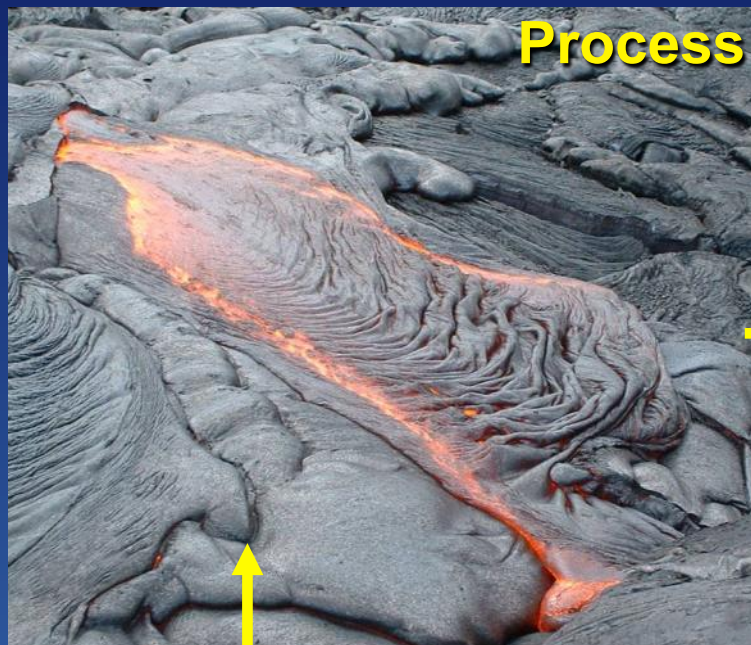
A PLANETARY SCIENCE FIELD TRAINING AND RESEARCH PROGRAM AT THE ZUNI-BANDERA VOLCANIC FIELD, NM



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**Inner Solar System Impact Processes
Center for Lunar Science and Exploration**



Remote
Sensing

Mapping

Modeling

BACKGROUND: ZUNI-BANDERA, NM

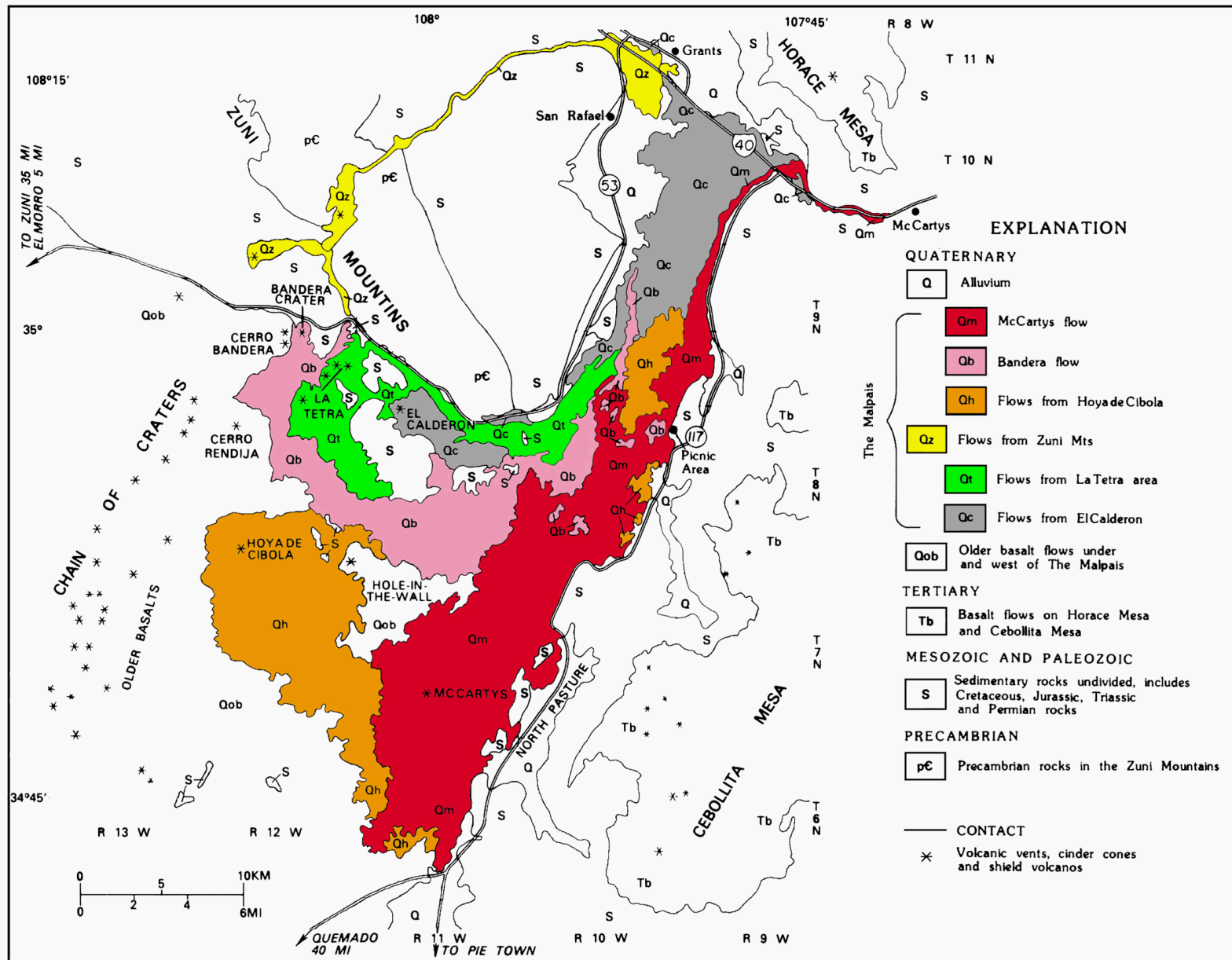


Figure 1. Geologic map of El Malpais and surrounding area, New Mexico.

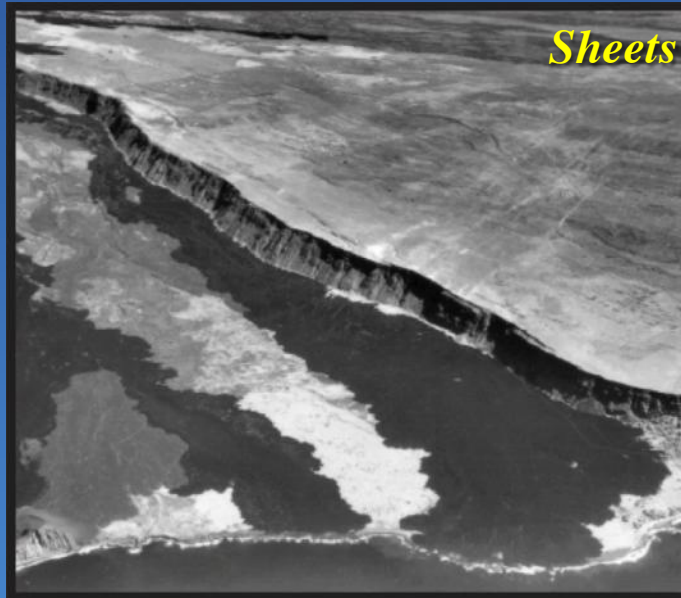
LAVA FLOWS



Channels



Tubes



Sheets

SHEETS

- Tabular units
- Large surface areas
- Inflation
- Emplacement over low slopes



LAVA TEXTURES



- Flow textures:
 - 'a'ā
 - pāhoehoe
 - disrupted pāhoehoe



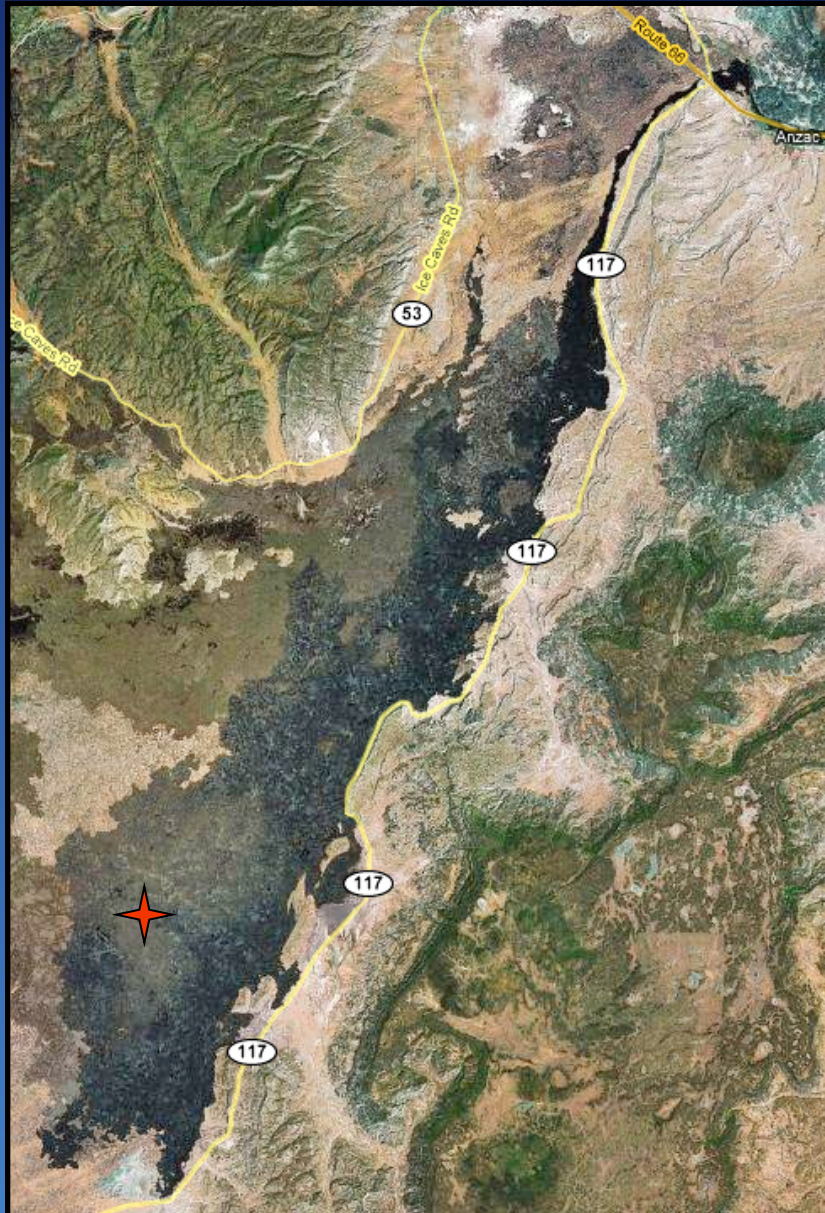
BACKGROUND: BASALTIC VOLCANOLOGY

- **Inflation**
 - Observed inflating lobes at flow fronts, HI
 - Enables 10s cm thick flows to attain thicknesses of meters in days to weeks



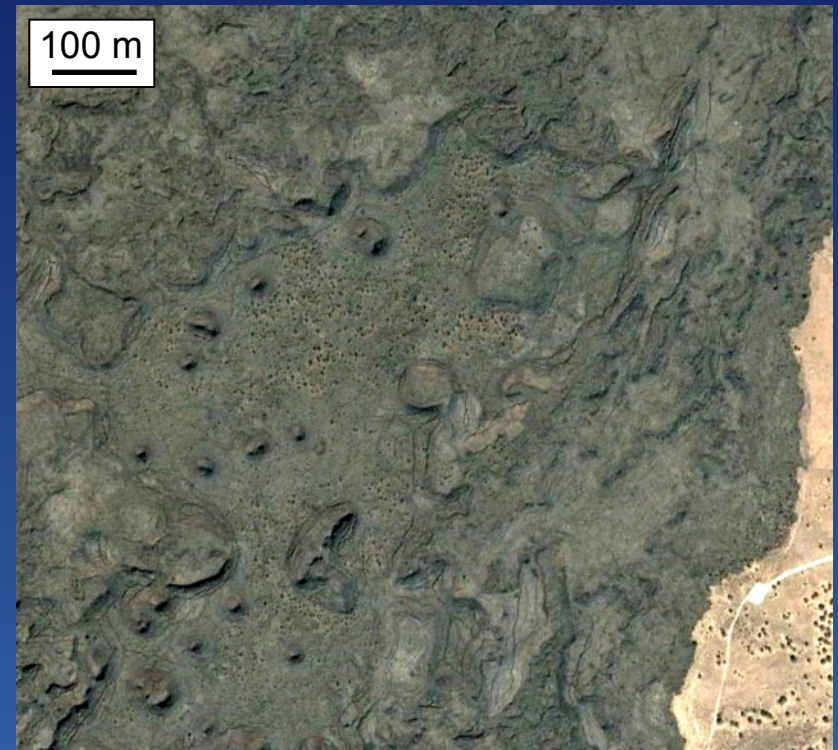


McCARTYS, NM



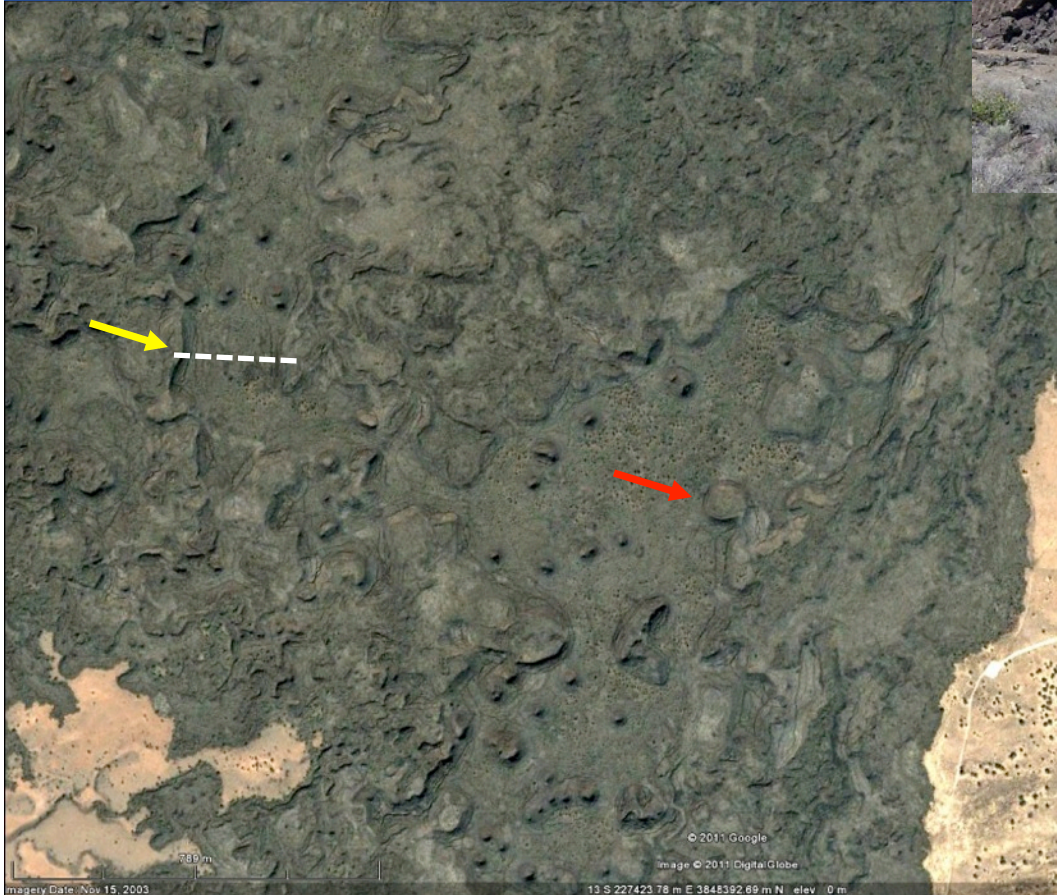
- **Tholeiitic basalts**
 - Quartz normative near vent
 - Olivine normative away from vent
- **48 km**
- **189 km²**
- **7.9 km³**
- **~ 3000 YBP**
 - Cosmogenic
 - Radiocarbon
- **Compound, tube-fed, pahoehoe flow field**

PLATEAUS



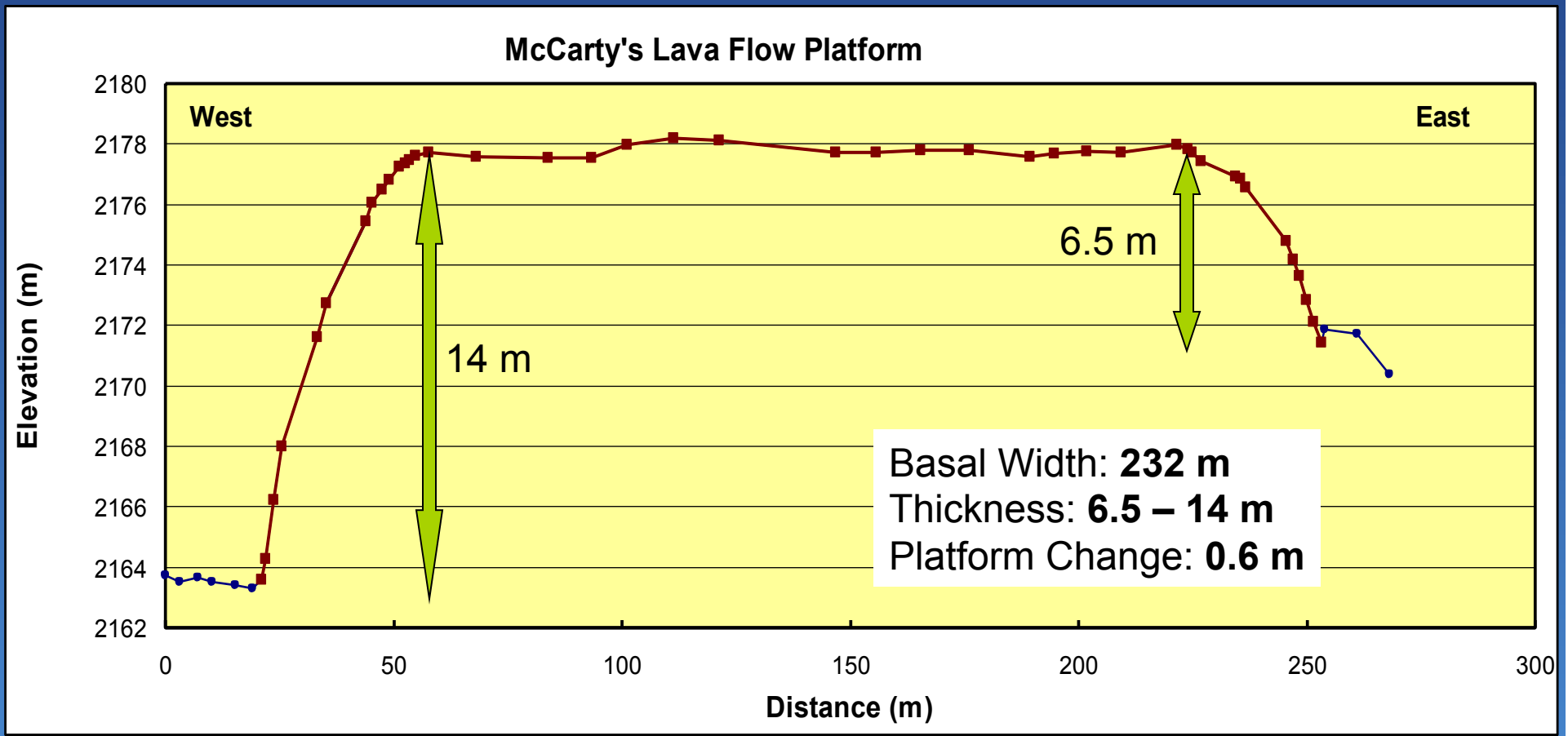
MARGINS

- Steeply dipping plates
- Occasionally overturned
- > 10 m in relief based on DGPS measurements



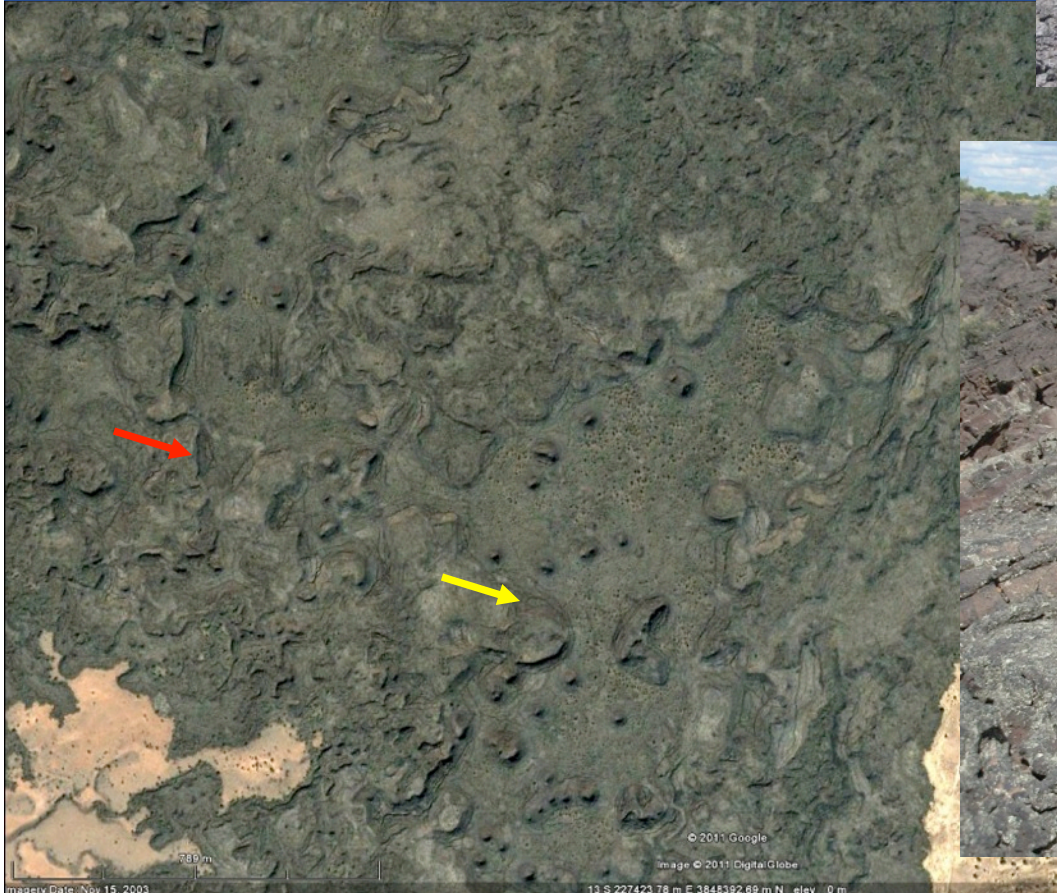
MARGINS

- Steeply dipping plates
- Occasionally overturned
- > 10 m in relief based on DGPS measurements



CLEFTS

- Dipping margins and horizontal plateaus separated by deep cracks
- Meters deep



PITS

- Vary from flat floored to conical
- Abrupt drop with overhanging roof to gradual increase in slope
- Floors covered in rubble, younger flows, or pre-flow surface





Lineated

- Parallel 10s cm grooves
- Aligned with flow direction
- Results form sheer during flow



Coils

- Also consistent with sheer zones within forming crust



Pahoehoe

- Pahoehoe ropes
- Also weathered away





Slabby/Rubbly

- **Tilted plates, sometimes reverse imbricated**
- **~10 cm thick**
- **Ropes and lineations present on upper slabs**
- **Disrupted original crust**



Wedges

- Blade-like features located in base of inflation clefts and along base of upper crust in pits
- Sometimes display downward sagging
- Found commonly in pit walls and clefts



INTERIOR

- Massive core
- Vesicle Layers near crust (10s cm depth)
- Disconnects core from surface texture



PLATES

- Pre-inflation plates that rafted apart
- Plates typically separated by fields of lava balls or rougher textures

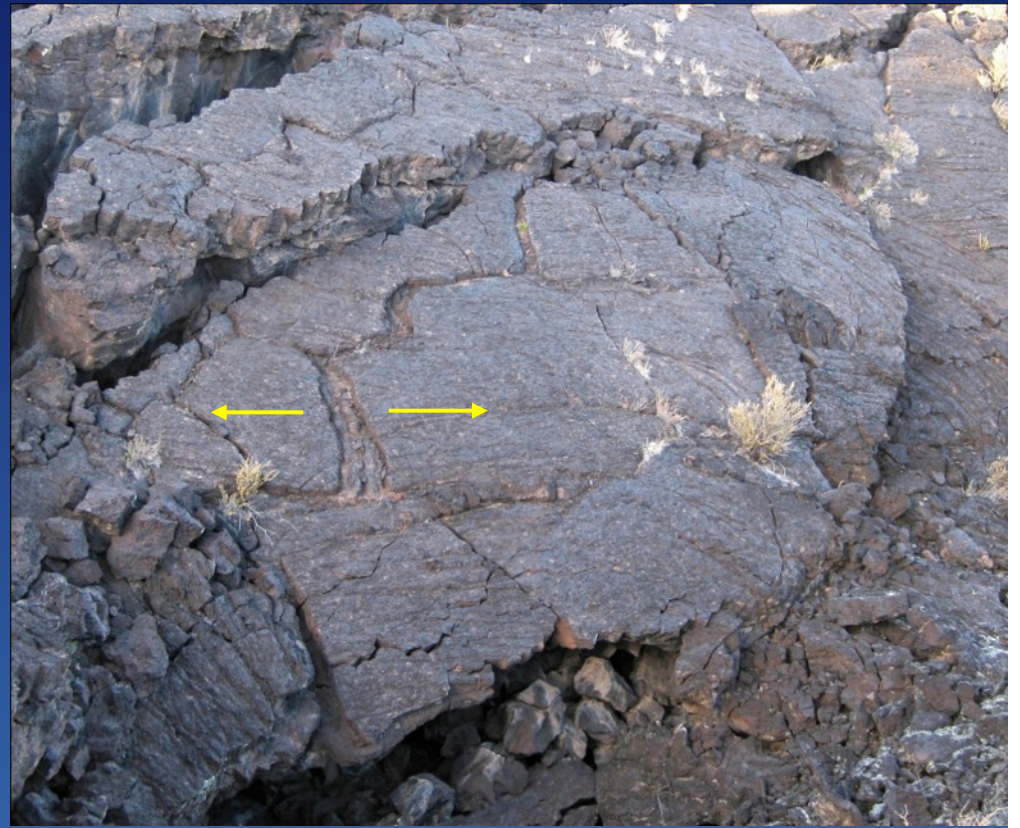


PLATE MARGINS

- Plates also bound by slabby texture (compression) or upwelled lava (tensile)



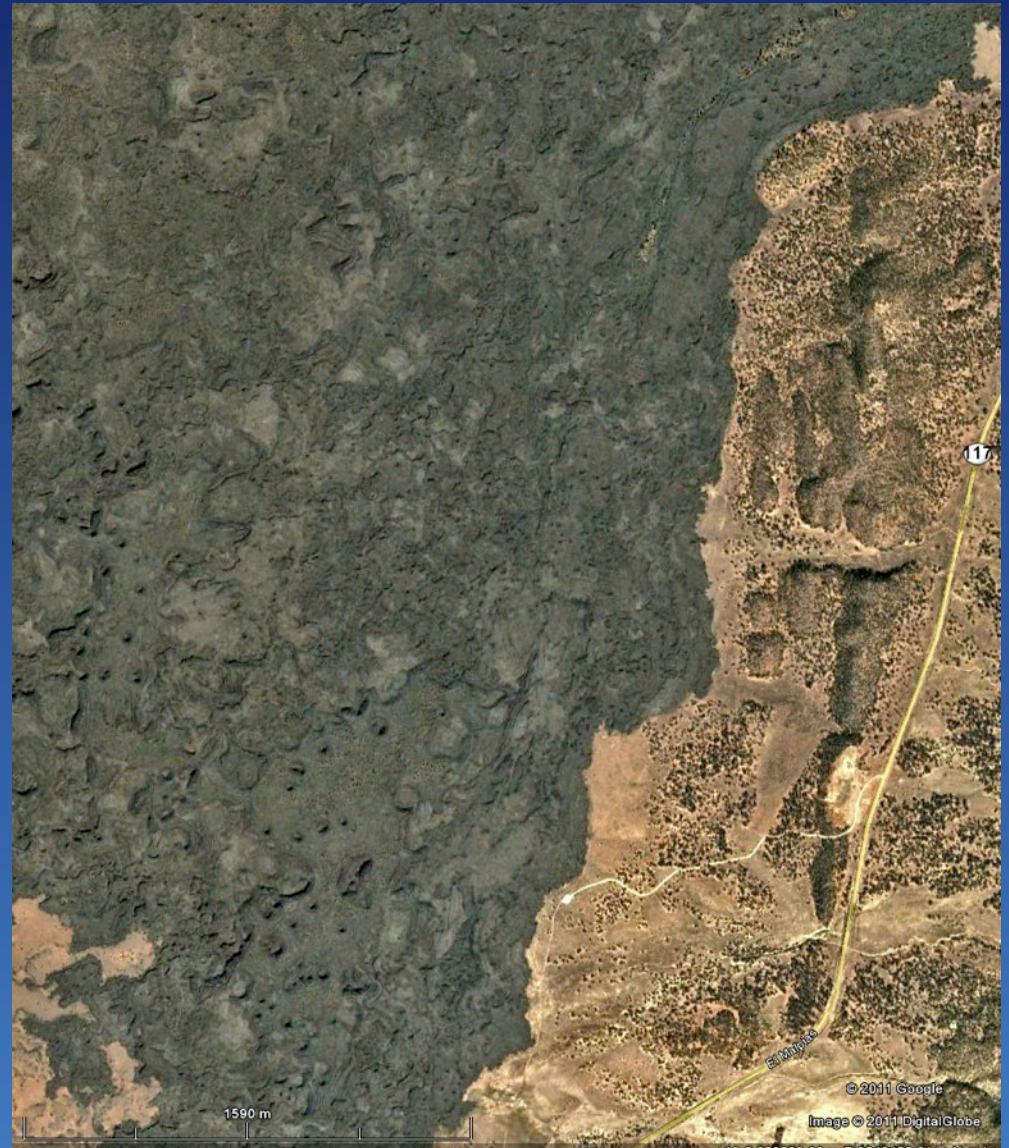
TEXTURE CHANGES

- Abrupt
- Not necessarily embayment
- No change of massive interior

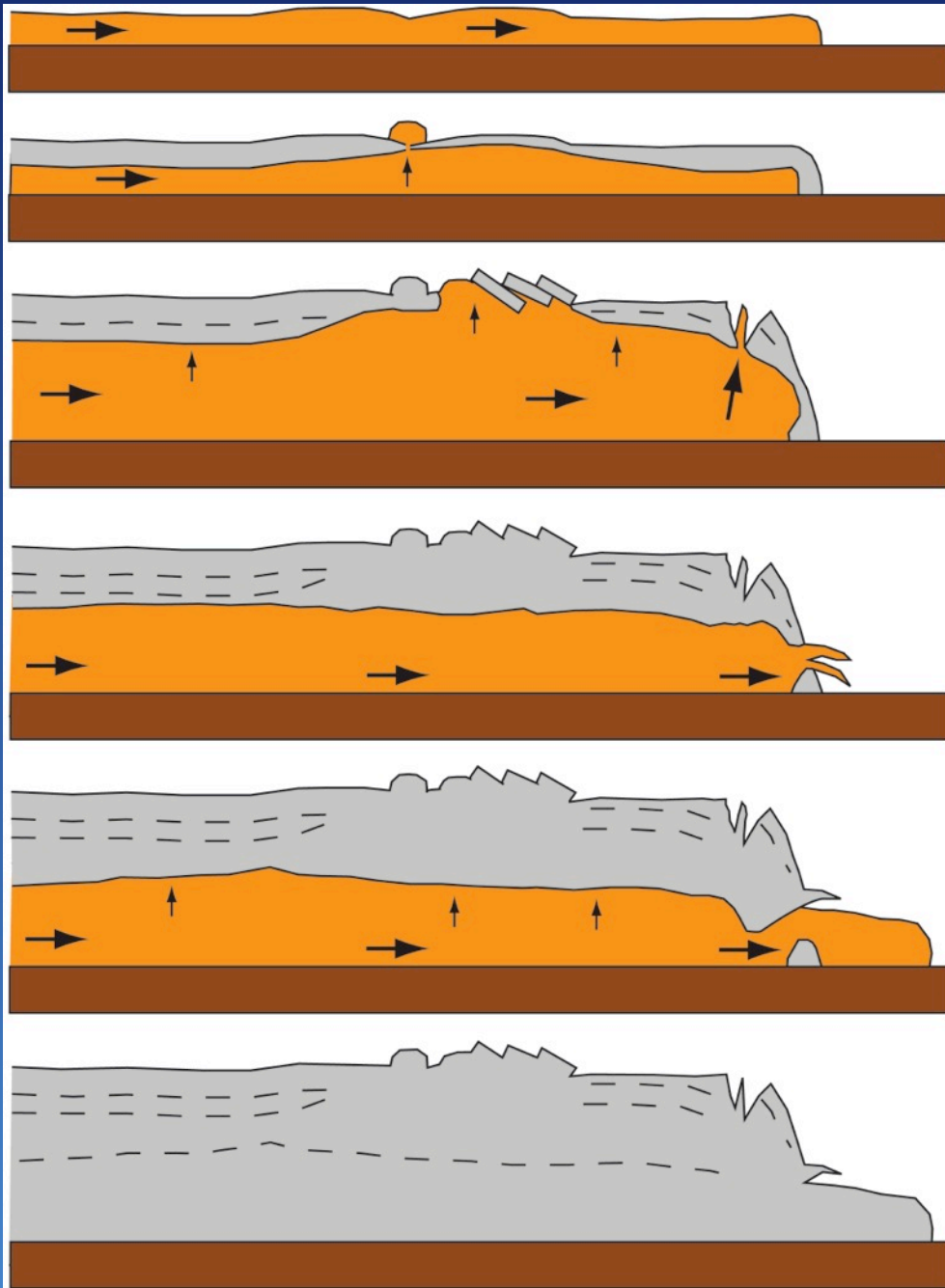


Emplacement History

- Questions:
 - Did inflation occur at McCartys
 - Did pits form by inflation or collapse
 - Which features are characteristic vs. diagnostic
 - What was the flow pathway



BASIC SEQUENCE



- Initial sheet, development of original crust (lineations, coils, ropes)
- Continued flux into sheet disrupts surface crust and causes inflation (plates, slabby, rubbly, balls)
- Vesicles focused along base of crust
- Breakouts can feed new inflated lobes
- Most textures could form regardless of inflation
- Squeeze-outs are our diagnostic for inflation

PIT FORMATION

- Inflation pits display a sense of collapse
- Critical point is to determine if inflation has occurred in the flow field

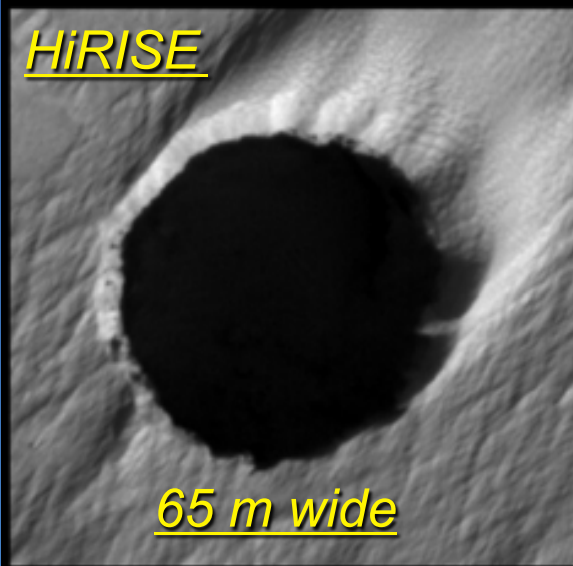


PITS

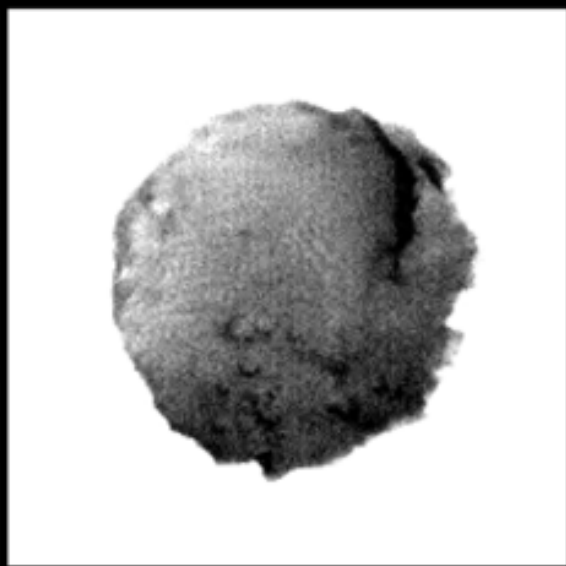
- Overhanging roof and flat floors are not necessarily diagnostic features of :
 - Lava tubes
 - Volcanic caves



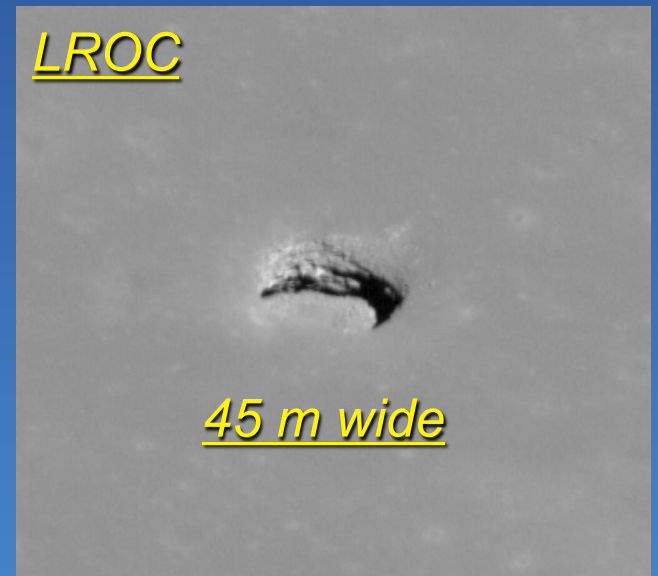
HiRISE



65 m wide



LROC



45 m wide

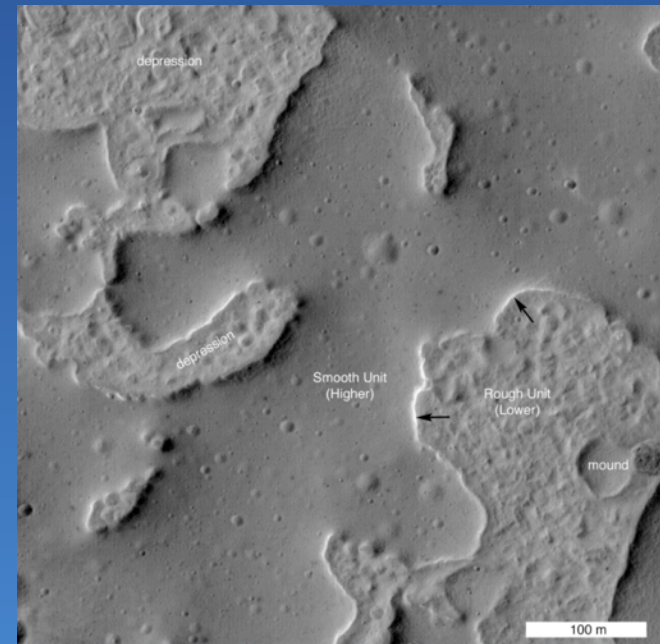
FLOW CONTACTS

- Flows were originally horizontal
- Working to differentiate between breakouts and uplifted embayment relationships



Field Conclusions

- Squeeze-outs diagnostic of inflation
- Plateaus, irregular pits, and terraced margins characteristic of inflation



Conclusions

- Inflation enables emplacement over long distances
- Occurs in all styles of basaltic terrain development
- Planetary inflation can be inferred from characteristic features
- Rough, slabby planetary lava flows not necessarily A'a flows

